

# Epitaxial Growth of Uniaxially and Biaxially Mismatched Silicide Films on Silicon

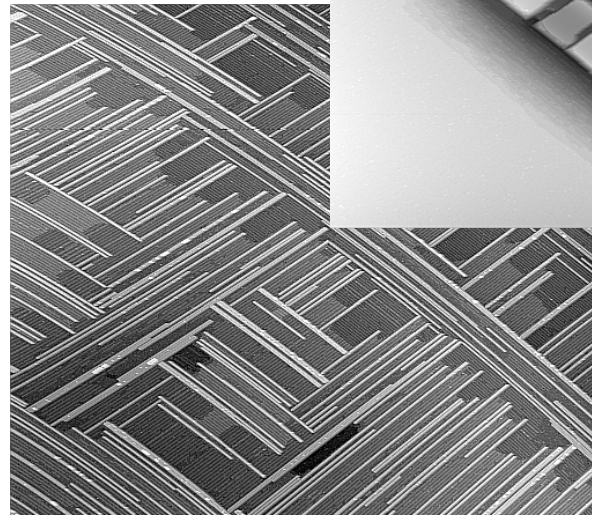
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DMR-0305472

Self assembled metallic nanostructures are formed when rare earth metal silicides are grown on the silicon surface. By varying growth conditions, we can grow radically different shapes such as parallel nanowires (lower left) and rectangular islands. One of the goals of our ongoing research is to understand the origin of these different shapes as a step towards total control of the nanostructures that we grow.

**3D island after 30 min  
annealing @700°C**



**nanowires 500 x 500 nm<sup>2</sup>**

Who?

A collaboration between Nogami (growth and STM) and Crimp (TEM). Additional LEEM work has been done at the MRL at U. Illinois (Champaign-Urbana)

What?

We are trying to understand the origin of different nanostructures that are formed when rare earth (RE) silicides are grown on silicon (001). RE earth silicides are a particularly good model system for a general study of the effects of mismatch and strain on grown film topography and island morphology since the mismatch can be continuously varied by picking different RE metals in the lanthanide series.

What we know so far:

For any given RE silicide, it is possible to form two or three different crystal structures, each with a different mismatch with respect to the substrate. This complicates the behavior, but at the same time provides a possible reason for the variety of island morphologies observed.

We are in the process of correlating island morphology with crystal structure (HRTEM). We have also observed three different classes of growth behavior during annealing (using LEEM) that we would also like to correlate with crystal structure.

So what?

We would like to find the reason for varied phenomena such as differing island morphologies and also differing growth behaviors for different island shapes. Similar phenomena are seen for other silicides on silicon, such as Ti silicide, and so a basic understanding of the phenomenon may allow us to more finely tailor the structure of a thin grown silicide film, or to grow self assembled quantum dots or wires as part of a nanoscale device structure.

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## Education:

This project has involved two graduate students, Ms. Chigusa Ohbuchi, and Mr. Gangfeng Ye. In addition, undergraduates have worked in the lab during the summers. We have made an effort to recruit women, such as Ms. Ohbuchi (now presently a post-doc in Japan), as well as two of our summer students.

Some of the results of our research have been used as examples in undergraduate level materials science courses at MSU. The materials science program is in the process of revising the curriculum with an eye towards expanding interests in electronic materials, nanomaterials, and biomaterials. This research project touches two of these three areas.